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ABSTRACT

This instructional lesson deals with the subject of magnitude and directional quantities. It is studied in physics and general science classes in middle or high schools. A previous knowledge of geometry is required for the students who would be using this learning activity. Beharvioral objectives are suggested. Thirty minutes is considered adequate for the exercise. The script, work sheet, and a list of the necessary equipment are included in the instructional packet. (EB)

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INTRODUCTION TO VECTORS
PART 1

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TEACHER'S GUIDE

PACKET NUMBER	531.1 S
SUBJECT	Physics and General Science
TITLE	Part I - Introduction to Vectors
LEVEL	Middle and High
PREREQUISITES	Knowledge of Geometry
BEHAVIORAL OBJECTIVES	1. Given a vector, to be able to state which are magnitude and directional quantities. 2. Given a vector, to be able to produce a pictorial representation of the vector. 3. Given two or more vectors, add two or more vectors graphically and determine the resultant vector graphically.
EQUIPMENT	12 inch ruler with metric scale (lower case) Protractor Dividers Pre-test - Post-test 7 Slides Graph paper Vocabulary list Student instructions Cassette tape recorder Slide viewer
TIME	30 minutes
SAMPLE EVALUATION	Work Sheet
SPACE REQUIRED	Carrel

STUDENT INSTRUCTIONS

1. Set up slides in proper number sequence.

2. Turn on tape recorder and follow the instructions given.

VOCABULARY LIST

PHYSICS AND GENERAL SCIENCE
PART I - INTRODUCTION TO VECTORS

1. Vector	A quantity having both magnitude and direction.
2. Resultant Vector	A new vector which represents the addition of two or more vectors.

SCRIPT

PHYSICS AND GENERAL SCIENCE
PARTS I - INTRODUCTION TO VECTORS

How many times have you been stopped by a stranger in a car or on the street asking you, "Do you know the directions to such and such a place?" Your answer to such a question was, "You go down this road for ___blocks, then go to the next red light, turn left"-- and so on.

These directions are what physicists call "vectors". They contain two basic parameters - how far and in what directions. These two parameters define a "vector".

A vector is a quantity that has magnitude (in the case above - how far) and the direction in which the magnitude is operating.

Go to Problem No. 1. Turn off the tape recorder. Turn off slide projector.

Did you make a mistake? Most people who do this probably will have drawn a line straight up from POINT A, 5 centimeters long and upon checking the slide found that the correct answer was a line of 5 centimeters in length or magnitude drawn to the right of POINT A. It is very important when dealing with vector that you make sure to define the direction or to use a given reference. In problem No. 1, a reference to north was given. In most cases dealing with vector problems, the student will establish his/her own reference, however, the student should always check to see if either the magnitude or direction paramecer are pre-established.

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Go to Problem No. 2. Turn off tape recorder. Turn off slide projector.

The answer to Part (b) Two blocks south of the starting point is a new vector. It is important when dealing with vector to express your answers with some point of reference. In this case, the best "point of reference" was the starting point.

Now let us review what has been presented about vector so far:

1. A vector is a quantity which has magnitude and direction.
2. A vector can be represented by a drawing.
3. A vector has a "point of reference" from which other vectors can be defined.
4. A vector representation must have given parameters, i.e. direction and magnitude notation.

If the above is understood, continue. If not, review the material presented so far listing those points you do not understand and see your teacher for further help.

So far we have dealt with a single vector only. In writing a vector on paper, a vector is usually designated by a lower case letter with an arrow or bar drawn over it.

Turn on slide projector. Slide No. 3. In this slide, Part (a) there are two vector namely, $\vec{a}$ and $\vec{b}$. The vectors have both magnitude and direction. The magnitude of the vector being represented by the length of the drawn vector and the direction by the arrow point. In part (b)

the two vectors are added together, in other words, a + b. The rule for adding vectors is as follows: Draw the first vector - from the arrow point of the first vector, draw the second vector.

It does not matter which vector, i.e., $\vec{a}$ or $\vec{b}$, is drawn first, the end point will be the same if $\vec{b}$ is drawn first and $\vec{a}$ added or $\vec{a}$ is drawn first and $\vec{b}$ added. The important point of vector construction is that the tail of the next added vector is added to the arrow point of the preceding vector, as in (c) .

Turn off slide projector. Go to Problem No. 3. Turn off tape recorder.

In this slide, note the following points:

1. Labeling of the reference points (starting and end points, legend, the labeling of the vectors themselves.)

1. The end points are the same in (a) and (b).

If you wish to study the above further, turn off the tape recorder. Go to slide No. 5.

To define the end point with reference to the starting point, draw a new vector from the starting point to the end point. In (a) the new vector is called $\vec{c}$ vector (c). This is called the "resultant vector". $\vec{c}$ is equal to $\vec{a}$ plus $\vec{b}$, and the mathematical expression is written as it

appears on the slide. Caution: This is not a simple addition problem. One can not add the units of $\vec{a}$ and $\vec{b}$ and get the units of $\vec{c}$. The reason for this is that a vector has both magnitude and direction as its parameter and not just magnitude alone. How does one find the parameters of $\vec{c}$? Referring back to the definition of a single vector - a quantity having both magnitude and direction - $\vec{c}$ can be drawn by itself as in (b). Take a pair of dividers, using the unit scale from the legend, you will find the magnitude of $\vec{c}$ to be 5-units. But, remember that this i only half of the answer - a vector has two parameter, magnitude and direction. In order to get the remaining parameter, use a protractor and measure the angle that c makes with 000^{o}, approximately 53^{o}. You should recognize this as the 3, 4, 5 triangle from your math classes.

Now, let's try two more problems and see if you can do them correctly.

Turn off slide projector. Go to Problems No. 4 and No. 5. Turn off tape recorder.

Did using the graph paper help you in plotting the individual vectors? Let us review all that has been presented in PART I.

1. A vector is a quantity having both magnitude and direction.
2. A vector can be represented on graph paper by a line of definite length (magnitude) and drawn in a definite direction.

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PART I - INTRODUCTION TO VECTORS

3. When drawing a vector, it is important to establish a legend.
4. All vectors are drawn from a "point of reference".
5. When adding two or more vectors, one places the "tail" of the second vector at the arrow point of the first vector.
6. A "resultant" vector is a vector which represents the sum of two or more vectors added together.
7. Vector solving is <u>not</u> done mathematically by arithmetic means.

You are now ready to take the post-test. After completing it start on PART II.

Turn off all equipment and return all tools to the teacher in the envelope and pick up the POST-TEST.

PROBLEM NO. 1

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GIVEN:

A man walked 15 miles north from Point A (use a scale of 1-cm = 3-mi.)

DO:

Draw the vector

LEGEND

A

For the answer to this problem see Slide No. 1.

Turn on tape recorder.

PROBLEM NO. 2

GIVEN:

A man leaves his front door and travels two blocks west, then three blocks east, five blocks south and two blocks west. (let 1 block - 1 inch.)

DO:

(a) Draw a picture of the man's path.

(b) How far is the man from his home?

LEGEND

(starting point)

•

For the answer to this problem, see Slide No. 2

Turn on tape recorder.

PROBLEM NO. 3

GIVEN:

$\vec{a}$ = 3-units @ 000°

$\vec{b}$ - 4-units @ 090°

(1-unit = 2-cm.)

DO:

(a) Draw $\vec{a} + \vec{b}$

(b) Draw $\vec{b} + \vec{a}$

For the answer to this problem, see Slide No. 4

Turn on tape recorder.

PROBLEM NO. 4

GIVEN:

$\vec{a}$ = 5-miles @ 060

$\vec{b}$ = 5-miles @ 150

(1-inch = 1-mile)

DO:

find $\vec{c}$ graphically

HINT: Do problems 4 and 5 on graph paper.

For the answer to this problem, see Slide No. 6.

Go to Problem No. 5

PROBLEM NO. 5

GIVEN:

$\vec{a}$ = 4-newtons @ 000°

$\vec{b}$ = 5-newtons @ 090°

$\vec{c}$ = 3-newtons @ 135°

(1-newton = 2-cm.)

DO:

Find $\vec{r}$ graphically

For the answer to this problem, see Slide No. 7

Turn on tape recorder.

PRE-TEST

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NAME_____

CLASS_____ SECTION_____ TEACHER_____

1. GIVEN:

$\vec{a}$ = 5-units @ 045

$\vec{b}$ = 6-units @ 090

(1-unit = 2-cm.)

DO:

(a) Plot $\vec{a}$, $\vec{b}$ so that $\vec{a} + \vec{b} - \vec{c}$

(b) Find $\vec{c}$

2. GIVEN:

$\vec{a}$ = 4-newtons @ 000

$\vec{b}$ = 5-newtons @ 090

$\vec{c}$ = 3-newtons @ 135

DO:

Find $\vec{d}$ graphically

POST-TEST

NAME_____

CLASS_____ SECTION_____ TEACHER_____

1. GIVEN:

$\vec{a}$ = 45-miles @ 090

$\vec{b}$ = 45-miles @ 000

$\vec{c}$ = 15-miles @ 315

(1-unit = 1/2-mile)

DO:

Find $\vec{d}$ graphically

2. GIVEN:

$\vec{a}$ = 8-miles, south

$\vec{b}$ = 4-miles, north

$\vec{c}$ = 4-miles, west

(1-unit = 2-cm.)

DO:

Find $\vec{d}$ graphically

3. GIVEN:

$\vec{a}$ = 5-kilograms @ 090

$\vec{b}$ = 10-kilograms @ 270

$\vec{c}$ = 5-kilogram @ 090

(1-kilogram = 1-cm.)

DO:

Find $\vec{d}$ graphically